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AN EFFECT OF GROWTH REGULATORS ON RESTRICTION OF UMBEL ORDERS IN SEED PRODUCTION OF ONION cv CO (On) 5

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ABSTRACT

A field experiment was conducted with onion cv. CO (On) 5 to study the effect of growth regulators spray on restriction of umbel orders on seed set percentage and seed quality in onion. The results revealed that among the sprays, spraying of paclobutrazol (100 ppm) and NAA (100 ppm) at the first flower stalk emergence (33drd days after sowing) and second spray at 10 per cent flowering stage (44thdays after sowing) recorded enhanced seed recovery and yield. In the present investigation results showed that significant differences observed in all the physiological characters viz., speed of germination, germination, root length, shoot length, dry matter production and vigour index due to the spray of Paclobutrazol @ 100 ppm (22.3, 92 per cent, 6.3 cm, 8.7 cm, 17.1 mg 10 seedlings $^{-1}$ and 1380) which was on par with NAA @ 100 ppm (22.1, 91 per cent, 6.4 cm 8.9 cm 17.4 1 mg 10 seedlings $^{-1}$ and 1392) compared with control (20.1, 80 per cent 5.3 cm 6.8 cm, 13.6 mg 10 seedlings $^{-1}$ and 968).

KEY WORDS: Onion, Growth Regulators, Umbel Order & Germination and Seed Yield

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Original Article

INTRODUCTION

Onion (*Allium cepa* L.)is an indispensable commercial biennial cool season cross pollinated crop used in many parts of the world. It is widely used as a most important vegetable crop which is grown in temperate and tropical regions of the world.

Onion being an indeterminate crop produces flowers in different time periods. At the time of blooming the plant first produces the flower stalk. At the tip of the stalk an inflorescence known as first umbel or primary umbel and it's continuous up to fourteenth order at the maximum if the climate is preferable for the flowering. Plants with more umbels show a decreased seed yield and quality. It is important to check out the umbel production to produce high quality seeds and good seed yield.

Hence the assessment of flowering pattern with reference to umbel production and their influence on seed yield and quality is very much essential to determine the optimum umbel number for harvesting high quality seeds. With this back ground study were conducted to find out the influences of different plant growth regulators on the restriction of umbel orders in onion for enhancing the seed yield and quality.

MATERIALS AND METHODS

Onion cv.CO (On) 5 seed bulbs were the base material for the present study; Field experiment were conducted at Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during Rabi 2018 and laboratory experiments are carried out at the Department of Seed

Science and Technology, Tamil Nadu Agricultural University, Coimbatoreduring 2018-2019.

The experiment was conducted with statistical design of Randomized Block Design (RBD) in a plot size of 2 x 1 m under irrigated condition with six treatments and four replications. The treatments details were as follows:

- **T_1** - Control
- **T_2** - Foliar application of NAA @100
- **T_3** - Foliar application of humic acid @ 1 %
- **T_4**–Foliar application of NPK 19:19:19 @ 1 %
- **T_5** - Management of umbel numbers by manual clipping
- **T_6** - Foliar application of paclobutrazole @ 100 ppm

In each treatment twenty plants were taken from all the replications and the following observations were recorded.

Days for Initiation of Floral Phenology

Number of days that took for flower stalk initiation, spathe opening, flower opening, 50 per cent flowering, completion of flowering, completion of pollination and attainment physiological maturity of first, second, third……n^{th} order umbels from 20 randomly selected plants were recorded and the mean values was expressed in days.

Number of Umbels Plant^{-1}

The total sum of umbels from randomly selected 20 plants was counted and the mean value was expressed as the number of umbels plant^{-1}.

Umbel Diameter (cm)

The umbels were harvested at physiological maturity and the diameter of the first, second, third n^{th} order umbels from 20 randomly selected plants were measured with a scale by keeping it across the stalk at the middle portion of the umbel and the mean value was stated in centimetre.

Umbel Fresh Weight (g)

The fresh weight of the first, second, third n^{th} order umbels from 20 randomly selected plants were weighed in digital balance and the mean value was clearly expressed in gram.

Umbel Dry Weight (g)

After taking fresh weight of the first, second, third n^{th} order umbels from 20 were randomly selected plants, the umbels were dried in the shade for two days and then in hot air oven, preserved at 85 $\pm$ 1°C for 24 hr. to bring down the moisture content and is cooled in a desiccator and weighed in a digital balance. The mean value was expressed in gram.

Number of Capsules Umbel^{-1}

The total sum of capsules, number of ill filled capsule and filled capsule in first, second, third n^{th} order umbels from 20 randomly selected plants were counted and the mean values was clearly expressed as number of capsulesumbel^{-1}.

Seed Set per Cent

The filled and ill-filled capsules in first, second, third n^{th} order umbels from randomly selected 20 plants were counted, the seed set per cent was calculated as follows and the mean values was stated in percentage.

$$\text{Seed set per cent} = \frac{\text{Number of filled capsules umbel}^{-1}}{\text{Total number of capsules umbel}^{-1}} \times 100$$

1000 Seed Weight (g)

The 1000 seed weight for the seeds from first to second, third n^{th} umbel orders are randomly selected from 20 plants and were estimated using 8 x 1000 seeds and the mean value was expressed in gram.

Yield Characters (g)

Seed yield $umbel^{-1}$, Seed yield $plant^{-1}$ and Seed yield $plot^{-1}$ of first, second, third n^{th} order umbels from the randomly selected 20 plants were recorded, mean values were expressed in gram.

Seed Germination (%) (ISTA, 2013)

The germination test was done in the paper medium as per the procedure ordered by ISTA with four replicates of 100 seeds. The test conditions were 25 ± 2ºC and 95 ± 5 per cent RH was maintained in the germination room illuminated with fluorescent light**.** The seedlings were evaluated after twelve days and the normal seedlings with "knee bent" were counted and expressed as germination percentage.

Speed of Germination (Maguire, 1962)

The germination test was conducted in between paper method with four replicates of 100 seeds and the total numbers of seeds germinated were counted from the 2nd day onwards up to 12^{th} day. The seeds that were germinated on each day were counted and the speed of germination was computed adopting the formula.

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + \ldots\ldots\ldots + \frac{X_n - X_{n-1}}{Y_n}$$

- $\mathbf{X_1}$**-** Number of seeds germinated at first count
- $\mathbf{X_2}$**-** Number of seeds germinated at second count
- $\mathbf{X_n}$**-** Number of seeds germinated on n^{th} count
- $\mathbf{Y_1}$**-** Number of days from sowing to first count
- $\mathbf{Y_2}$**-** Number of days from sowing to second count
- $\mathbf{Y_n}$**-** Number of days from sowing to n^{th} count

Root Length (cm)

From the standard germination test ten normal seedlings were randomly selected and the root length was measured from the collar region to the tip of the primary root and the average was distinctly expressed in centimetre.

Shoot Length (cm)

From the standard germination test ten normal seedlings were randomly selected and the length from the collar region to the tip of the shoot was measured as shoot length and the average was stated in centimetre.

Dry Matter Production (ISTA, 2013)

The seedlings that were taken for growth measurement were placed in a paper cover and dried in shade for 24 h and then kept in an oven maintained at 85 ± 2^{o}C for 24 h. From the hot air oven the dried seedlings were removed and cooled in the desiccators over silica gel then the dry weight was recorded and the mean values were clearly expressed in g seedlings^{-10}.

Vigour Index (Abdul-baki and Anderson, 1973)

Vigour index values were calculated by using the below given formula and the mean values was expressed in whole number.

Vigour index = Germination (%) x Total seedling length (cm)

RESULTS AND DISCUSSIONS

Foliar application is credited with remarkably rapid absorption and nearly complete utilization of nutrients, elimination of leaching losses and fixation and helps in regulating the uptake of nutrient by plants (Manonmani and Srimathi, 2009).

In the present study, the growth regulator of paclobutazol @ 100 ppm, NAA @ 100 ppm, humic acid @ 1 per cent, NPK 19:19:19 @ 1 per cent and manual clipping of umbels were evaluated for restricting the later formed umbels in aggregatum onion cv.CO (On) 5. Growth regulator sprays were given at two stages that is after the first flower stalk emergence on 33rddays after sowing and another at 10 per cent flowering stage on 44th days after sowing. The result of the present experiment revealed that the number of days required for flower stalk initiation, flower opening, 50 per cent flowering and days for physiological maturity were statistically significant variation with different growth regulators spray and in manual clipping.

Among the growth regulators, minimum number of days taken for flower stalk initiation and spathe opening were exhibited in plants sprayed with paclobutrazol @ 100 ppm (38.5 and 45.1 days) which was on par with NAA @ 100 ppm (39.3 and 46.4) while maximum days were taken in unsprayed control (43.6 and 48.6.) (Table 1).

Days for flower opening and 50 per cent flowering differed significantly among different growth regulator spray. The minimum days taken for flower opening and 50 per cent flowering were recorded in paclobutrazol @ 100 ppm (53.2 and 56.3) which was followed by NAA @ 100 ppm (55.4 and 59.3) while maximum days were taken in unsprayed control (58.52 and 61.6) (Table 1).

Statistically significant difference was observed in days for completion of flowering and physiological maturity among the growth regulator spray. The days to completion of flowering and physiological maturity commenced earlier in paclobutrazol @ 100 ppm (60.2 and 101.7), followed by NAA @ 100 ppm (63.4 and 105.8)and the maximum days was taken in unsprayed control (65.5 and 107.8) over all the treatments (Table 1).

Among the foliar sprays given for arresting the later formed umbels, the paclobutrazol @ 100 ppm spray restricted umbel numbers upto a minimum of (6) which was on par with NAA @ 100 ppm which also reduced umbel order to a minimum of (6), while the umbel production was higher inhumic acid 1% (13) compared to control (11). Thus the spray of paclobutrazol altered the growth and development of onion by restricting the umbel orders. The similar results are confirmed by vinothini *et al.* (2018) in groundnut plant sprayed with NAA 200 ppm during 60 DAS after peak flowering stage hinders the flowering in later stages which helps the early formed flowers to use the source effectively (Table 1).

The number of umbels plant^{-1} is very imperative in seed yield. Paclobutrazol significantly decreased the number of umbels as compared to control (Ashrafuzzaman *et al.,* 2009). The higher concentration of paclobutrazol inhibits induction of flowering. The present study in onion plant sprayed with paclobutrazol @ 100 ppm and NAA @ 100 ppm during 33 DAS at flower stalk initiation stage inhibits the late formed flowers which helps the early formed flowers to utilize the source effectively resulting in production of more number of filled capsules, filled seeds and lesser number of illfilled capsules by improving the source-sink relationship in onion. However, Ashrafuzzaman *et al.* (2009) observed that paclobutrazol spray @ 80 ppm significantly reduced plant height, number of tillers per bulb, number of leaves plant-1 and length of scape in onion (Table 1).

The umbel diameter differed significantly between the different growth regulators spray. The Maximum value was recorded in paclobutrazol @ 100 ppm (5.6 cm) which was on par with NAA @100 ppm (5.5 cm) while it was minimum in control (4.6 cm). Paclobutrazol (PBZ) is a triazole derivate and inhibits gibberellin (GA) biosynthesis and abscisic acid (ABA) catabolism. In addition, paclobutrazol induces various plant responses such as reduced shoot growth reduction and enhances chlorophyll synthesis, delays leaf senescence, improves water use by reducing transpiration rate and increases assimilate partitioning from leaves to reproductive parts (Davis et al., 1991). However, Ashrafuzzaman et al.(2009) reported that the yield contributing factors viz., number of flowers, umbels per bulb, umbel diameter, 1000 seed weight and seed yield were not influenced by paclobutrazol 80 ppm in onion (Table 1).

The observation on yield parameters revealed that, 1000 seed weight, seed yields umbel^{-1}, seed yield plant^{-1}and seed yield kg / ha were recorded maximum in plant sprayed with paclobutrazol @ 100 ppm (3.37 g, 0.834 g, 6.82 g and 596.75 kg) which was on par with NAA @ 100 ppm (3.34 g, 0.823 g, 6.73 g and 588.75 kg) and the minimum was yield recorded in control (2.81 g, 0.510 g, 6.15 g and 538.13 kg) (Table 2).

The resultant seed of paclobutrazol @ 100 ppm spray treatment recorded was 92 per cent of seed germination which was on par with NAA @ 100 ppm (91 per cent) and the lowest germination percentage was observed in control (80 per cent). The speed of emergence, shoot length, root length, dry matter production and vigour index were also was on par for paclobutrazol @ 100 ppm and NAA @ 100 ppm that is (22.3, 8.7 cm, 6.3 cm, 17.1 mg 10 seedlings^{-1} and 1380) and (22.1, 6.4 cm, 8.9 cm, 17.4 mg 10 seedlings^{-1}, 1392) while in control it was minimum (20.1, 5.3cm, 6.8cm, 13.6 mg 10 seedlings^{-1}, 968) (figure 1&2).

Thus the study highlighted that foliar spray with paclobutrazol @ 100 ppm or NAA @ 100 ppm twice at first flower stalk emergence (33 DAS) and at 10 per cent flowering stage (44 DAS) improved the seed yield and resultant seed quality characteristics.

Flower production (umbels) in plants is known to be highly influenced by the plant growth regulators (PGR). The higher concentration of PGR's inhibits induction of flowering only when they are applied before translocation of

flowering hormone is complete (Salisbury, 1957). Restriction of umbel order through manual clipping or chemical spray with PGR will arrest the later formed umbels. In this context, foliar application of growth retarding substances may restrict the umbel orders.

It is known that the use of synthetic growth regulators have their effects through changing the internal levels of the naturally occurring hormones, thereby causing the modification of growth and development in the desired direction and to the desired extent (Mathur,1971; Singh *et al*.,1982). Plant growth retardants have been used to modify the growth and development of many vegetable crops (Berova et al. 2002). Growth retardants are known to reduce inter-nodal distance, thereby enhancing source-sink relationship and stimulate the translocation of photo assimilates to the sink (Luib *et a*l., 1987). The enhanced source-sink relationship with the use of plant growth regulators stimulates the translocation of photo assimilates, thereby increasing the productivity.

CONCLUSIONS

Onion is an indeterminate crop, produces continuous flowering with umbel production ranged from six to eighteen umbels depends upon crop management, the seeds of the early formed umbels recorded superior seeds quality characters than the seeds of late formed umbels. The restriction of umbels by manual clipping or growth regulator spray resulted in production of maximum quality seeds than the present study confirmed that foliar spray with paclobutrazol @ 100 ppm at 33rd and 44th days after sowing restricted the umbel number to (6) respectively resulted in enhanced seed yield of 15.44 per cent that the control. The seed quality characters *viz*, germination, seedling length and vigour index were found to be superior recorded 15 per cent enhanced germination and 43enhanced vigour index than the control.

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APPENDIES

Table 1: Effect of Foliar Application of Growth Regulators on Flowering Pattern of Onion cv. CO. (On) 5

Treatment	Days for Flower Stalk Initiation	Days for Spathe Opening	Days for Flower Opening	Days for 50% Flowering	Days for Completion of Flowering	Days for Completion of Pollination	Days for Physiological Maturity	Number of Umbels Plant^{-1}	Umbel Diameter (cm)	Total Number of Capsules Umbel^{-1}	Seed Set %
Control	43.6	48.0	58.5	61.6	65.5	83.0	107.8	11	4.6	90.2	55.7
Manual clipping	40.0	46.7	57.5	60.3	64.7	82.7	106.9	8	5.0	96.5	62.0
Paclobutrazol @ 100 ppm	38.5	45.1	53.2	56.3	60.2	77.4	101.7	6	5.6	121.3	72.9
NAA @ 100 ppm	39.3	46.4	55.4	59.3	63.4	81.4	105.8	6	5.5	119.9	72.3
Humic Acid 1 %	39.6	46.6	57.4	60.1	64.5	82.5	106.0	13	5.3	111.3	66.7
NPK 1%	41.7	47.9	58.3	60.6	65.0	83.7	108.3	8	5.1	104.3	64.1
Mean	**40.5**	**46.8**	**56.7**	**59.8**	**63.9**	**81.8**	**106.1**	**8.6**	**5.2**	**107.3**	**65.6**
SEd	0.421	0.573	0.836	0.893	0.985	1.292	1.339	0.0710	0.081	1.235	0.881
CD (P=0.05)	0.898	1.221	1.782	1.904	2.100	2.755	2.854	0.15	0.172	2.632	1.879

Table 2: Effect of Foliar Application of Growth Regulators Spray on Seed and Seed Yield Characters of Onion cv.CO (on) 5

Treatment	1000 Seed Weight (g)	Seed Yield Umbel^{-1} (g)	Seed Yield Plant^{-1} (G)	Seed Yield /ha (kg)
Control	2.81	0.510	6.15	538.13
Manual clipping	2.93	0.534	6.43	562.63
Paclobutrazol @ 100 ppm	3.37	0.834	6.82	596.75
NAA @ 100 ppm	3.34	0.823	6.73	588.75
Humic Acid 1 %	3.17	0.579	6.56	574.00
NPK 1%	3.08	0.542	6.49	567.88
Mean	**3.11**	**0.637**	**6.53**	**571.54**
SEd	0.050	0.014	0.067	11.2833
CD (P=0.05)	0.106	0.031	0.142	24.0500

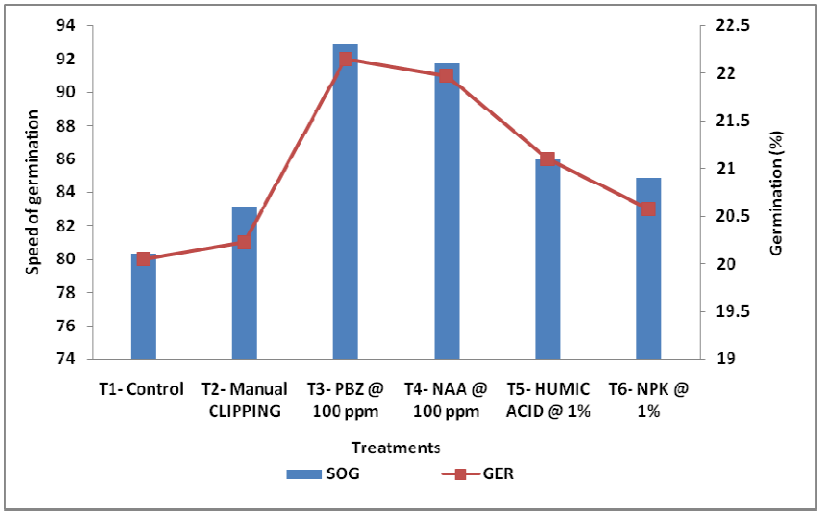

Figure 1: Effect of Foliar Application of Growth Regulators Spray on Speed of Germination and Germination per cent

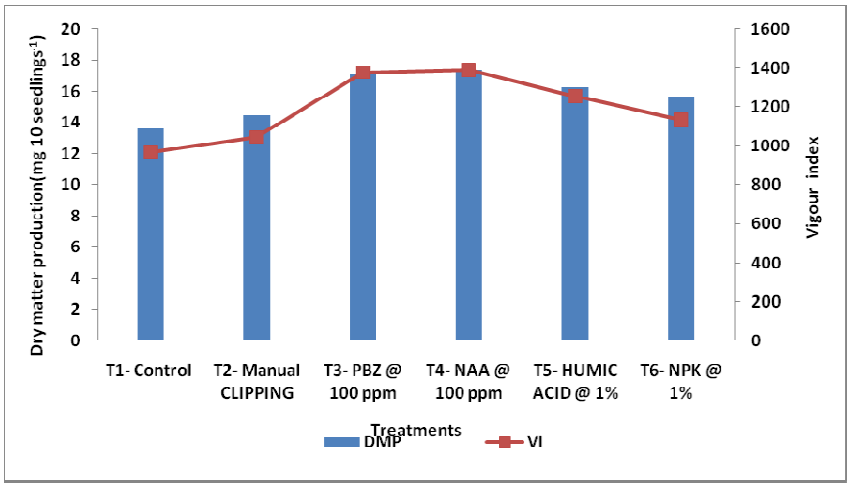

Figure 2: Effect of Foliar Application of Growth Regulators Spray on Dry Matter Production (mg 10 Seedlings^{-1}) and Vigour Index